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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Arieh Jehuda POLAK

Serial No.: 10/803,868 Group Art Unit: 1792

Filed: March 17, 2004 Examiner: Saeed T. Chaudhry

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Title: A SPRAY DEVICE AND METHOD OF USING THE SAME

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Enclosed is a certified copy of the corresponding Israeli patent application for which priority is claimed under 35 USC 119.

Country	Application No.	Filing Date:
ISRAEL	148040	February 6, 2002

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Respectfully submitted,

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Application No: **148040** **מספר בקשה:**

Date of application: **06/02/2002** **תאריך הבקשה:**

LIQUID SPRAY DEVICE — מכשיר לריסוס נוזלים

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Ref:14197/02

מכשיר לריסוס ושיטה לשימוש בו

A SPRAY DEVICE AND METHOD OF USING THE SAME

A SPRAY DEVICE AND METHOD OF USING THE SAME

Field of the Invention

The present invention relates to the field of spray devices. More particularly, the invention relates to a method and apparatus for directing a mist stream, which can be generated in an unenclosed area, with a predetermined diameter to a target location at a predetermined distance from the spray device.

Background of the Invention

One of the requirements for high milk production in summer is relieving heat stress. Several studies have determined that milk production can be increased by installing cooling systems. ("Interactions Between Body Condition at Calving and Cooling of Dairy Cows during Lactation in Summer," Flamenbaum et al , Journal of Dairy Science, Vol. 78, No. 10, 1995 and "Dry Period Heat Stress Relief Effects on Prepartum Progesterone, Calf Birth Weight, and Milk Production," Wolfenson et al, Journal of Dairy Science, Vol. 71, No. 3, 1988). A side benefit to the installation of such cooling systems is that the reproductive performance of cows can be improved with cooling.

A prior art cooling system generally consists of an air distribution duct for directing a turbulent air stream onto the cows and a separate water line that terminates with a nozzle which produces a spray. Nozzles are commonly used, in contrast with discharge directly from a hose, to conserve water. Sprinklers that are positioned in the feeding area of a dairy farm generally provide supplemental cooling, reducing the fan power needed and enabling a marginally hot cow to be much more comfortable. Since cows sweat only one-tenth as much as humans, a spray-fan cooling system conducts away surface heat and increases the vaporization of

moisture from the skin. This body cooling effect enhances comfort and increases milk production.

Although prior art systems provide adequate cooling, they suffer from some drawbacks. Firstly, an inordinate amount of water is wasted. The cooling water is not necessarily directed at the cows, but rather it is discharged throughout a wide region, e.g. within the feeding area, so that an optimal number of heated cows will be cooled by the spray of water. However, cows may not seek a spray-cooled comfort zone, and therefore the spray may not be effectively utilized. Water that does not impinge upon the hair coat of a cow falls to the ground. Secondly, the water that falls to the ground generally collects as puddles, serving as a source of diseases to the cows, such as mastitis, especially in combination with cow droppings, despite the constant operation of a fan that additionally functions as a means to dry the ground. Thirdly, water is sprayed at times on the face of the cows, thereby causing them much aggravation.

U.S. Patent 5,643,082 discloses an apparatus for generating a cool air stream in which a blower is attached to a window of a building. A water delivering tube having a spray nozzle secured to its front side is detachably disposed in front of the blower, so as to eject water therefrom in the form of mist particles. Holders are attached to the window frame to provide a gap between each spray nozzle and the blower, and the holders are pivotally fitted to the water delivering tube by supporting means. In addition to the relatively complicated structure of the apparatus, other drawbacks concerning the performance of this spray device include inefficient usage of water and an inability to direct the mist to a predetermined location. Also, the apparatus is not capable of operating in an unenclosed area. Thus this apparatus, when employed in a dairy farm, cannot direct the mist to the hair coat of a group of cows, but rather humidifies the hot air, resulting in a waste of water.

U.S. Patent 6,233,995 is directed to a method for cooling golf greens and other vegetation, using a fan with a tubular nozzle member fitted around the fan head.

All the methods described above have not yet provided satisfactory solutions to the problem of directing a spray of mist to a predetermined location.

It is an object of the present invention to provide a method and apparatus for directing a spray to a predetermined location.

It is another object of the present invention to provide a spray device that reduces water usage.

It is another object of the present invention to provide a spray device that has an uncomplicated structure.

It is still another object of the present invention to provide a method and apparatus for cooling cows with a spray of water, such that excess water does not collect on the ground.

Other objects and advantages of the invention will become apparent as the description proceeds.

Summary of the Invention

The present invention relates to a spray device, comprising a means for generating an air stream having a predetermined velocity and a nozzle unit with at least one inlet for the introduction therein of a liquid and a

separate set of nozzles corresponding to each of said inlets for the discharge of liquid therefrom, said nozzle unit fixedly attached to the central portion of said air stream generating means, such that said discharged liquid is entrainable by said air stream whereby to produce a mist stream capable of being propelled to a predetermined location, a lateral dimension of said mist stream having a measurable and controllable value at said predetermined location.

As referred to herein, the lateral dimension of the mist stream is measured at a direction perpendicular to the flow of the air stream and may be in a vertical or horizontal direction, or in any other desired direction.

The air stream generating means is preferably a fan having blades and a guard grille, the nozzle unit being centrally mounted on the downstream side of the grille and the blades defining a blade diameter.

Still preferably, but not limitatively, the nozzle unit comprises one or more nozzles essentially symmetrically positioned with respect to the center of the fan blades. As will be appreciated by a skilled person, the nozzle unit will preferably possess a "low profile," viz. will create the smallest possible disturbance to the stream of air generated by the fan.

More preferably, the nozzle unit is essentially concentrical with the fan blades.

The inclination of the fan with respect to a fan support is preferably adjustable, the direction of the mist stream thereby being adjustable.

The spray device preferably further comprises a check valve, said check valve being installed within each inlet to the nozzle unit.

The nozzle unit is preferably hollow with a substantially cylindrical, conical or pyramidal configuration.

In one aspect, the nozzle unit is provided with at least one partition, each partition defining two adjacent liquid circulation chambers, wherein the liquid introduced through a corresponding inlet circulates through a corresponding chamber and is discharged through a corresponding set of nozzles.

In one aspect, the length of the nozzle unit is greater than its outer diameter and a flange is used to mount the nozzle unit to the grille of the fan.

In another aspect, the periphery of the nozzle unit are provided with a plurality of apertures, a nozzle being insertable within each aperture. Each nozzle is equidistantly and circumferentially spaced from an adjacent nozzle, the maximum radial spacing between nozzles defining an effective diameter, wherein the effective diameter of the nozzles is less than the blade diameter of the fan.

The spray angle of each nozzle with respect to a longitudinal axis of the nozzle unit ranges from 0-75 degrees, and preferably is substantially 45 degrees.

In one aspect, a front face of the nozzle unit is formed with an aperture and a nozzle is insertable within said aperture, such that the spray angle of the nozzle is approximately 0 degrees with respect to the longitudinal axis of the nozzle unit.

The capacity of each nozzle preferably ranges from 5-50 liter/hr.

Each nozzle is preferably removable and replaceable.

In one preferred embodiment, the at least one liquid inlet is regulated by a control valve.

In another preferred embodiment, each liquid inlet is regulated by a control valve.

In another preferred embodiment, the spray device further comprises a timer, said timer being capable of communicating with an actuator of the control valve, whereby to maintain a cyclic operation of the spray device.

In another preferred embodiment, the spray device further comprises a controller and sensor, said controller operative to regulate the control valve in response to a value relating to ambient conditions sensed by said sensor.

The sensor is preferably selected from the group of temperature sensor, humidity sensor and wind speed sensor.

The controller is preferably operative to control the operation of the air stream generating means.

In another preferred embodiment a network of spray devices is provided, each spray device being one of the aforementioned spray devices.

In one aspect, the inlet to the network is regulated by a control valve.

In another aspect, the inlet to each spray device is regulated by a control valve.

In another aspect, the controller regulates a plurality of control valves.

The present invention is also directed to a method for directing a spray to a target location, comprising generating an air stream having a predetermined velocity, generating a spray of liquid, such that said spray of liquid is injected into said air stream and entrained thereby, whereby to produce a mist stream having a measurable and controllable lateral dimension; and allowing said mist stream to be propelled by said air stream for a predetermined length so that at said target location the lateral dimension of said mist stream is substantially of a predetermined value.

The air stream is preferably generated by means of a fan having a guard grille and fan blades.

The spray of liquid is preferably- but non-limitatively- generated by allowing a liquid having a sufficient flow rate to flow through a conduit and to be introduced into a nozzle unit which is mounted onto the grille of the fan, whereupon the liquid is discharged as a spray through each of a set of nozzles provided with said nozzle unit.

Each nozzle is preferably disposed at a spray angle and sufficiently spaced from an adjacent nozzle to define an effective diameter of the nozzles.

The discharges from each of the nozzles preferably converge slightly downstream from the nozzle unit.

The lateral dimension of the mist stream is controlled by modifying the value of at least one parameter selected from the group of effective diameter of the nozzles, distance to the target location, spray angle,

diameter of fan blades, velocity of air stream and density of the liquid that is propelled by the air stream.

The concentration of the mist stream is controlled by regulating the flow rate of the liquid to be sprayed and by changing the outlet size of each nozzle.

The mist stream may be used, by example, to cool overheated animals, to wash cars, to spray perfume in a wedding hall, to apply pesticide within a warehouse, to moisten textile fibers to be processed, to produce, to increase the moisture content within a greenhouse or to apply insecticide to plants grown within a greenhouse.

The present invention is also directed to washing a body, comprising the following steps:

a) generating an air stream having a predetermined velocity;
b) providing a nozzle unit with a first inlet and a second inlet for the introduction therein of water and of a chemical solution, respectively, and a first and second sets of nozzles corresponding to said first and second inlets, water and said chemical solution being capable of circulating in separate chambers within said nozzle unit;
c) allowing water to flow into said first inlet;
d) allowing a spray of water to be discharged from said first set of nozzles, such that said spray of water is injected into said air stream and entrained thereby, whereby to produce a first mist stream having a measurable and controllable lateral dimension and allowing said mist stream to be propelled by said air stream for a predetermined length so that at said target location said first mist stream is capable of moistening dirt particles attached to the surface of a body;

e) after a first predetermined period of time, allowing said chemical solution to flow into said second inlet;

f) allowing a spray of chemical solution to be discharged from said second set of nozzles, such that said spray of chemical solution, together with said spray of water, is injected into said air stream and entrained thereby, whereby to produce a second mist stream having a measurable and controllable lateral dimension and allowing said second mist stream to be propelled by said air stream for a predetermined length so that at said target location said second mist stream is capable of spraying said body and producing a foam thereon;

g) after a second predetermined period of time, preventing flow of said air stream, flow of water into said first inlet and of said chemical solution into said second inlet;

h) after a third predetermined period of time, repeating steps a)-d), water being introduced into said first inlet at a predetermined pressure;

i) after a fourth predetermined period of time, preventing flow of water; and

j) after a fifth predetermined period of time, transporting the washed body.

In one aspect, the body is that of a motor vehicle.

In another aspect, the body is an animal body.

In a preferred embodiment, the first predetermined period of time is approximately 1 minute, the second predetermined period of time is approximately 0.5 minute, the third predetermined period of time is approximately 5 minutes, the fourth predetermined period of time is

approximately 2 minutes and the fifth predetermined period of time is approximately five minutes.

In one aspect, the method further comprises, after step i), providing said nozzle unit with a third inlet and a corresponding third set of nozzles, allowing a spray of wax to be discharged from said third set of nozzles, and after a sixth predetermined period of time, preventing flow of wax.

According to a preferred embodiment of the invention, the sixth predetermined period of time is approximately 1 minute.

The chemical solution is preferably an aqueous solution comprising a compound selected from the group consisting of surfactant, aliphatic alcohol, aminoalcohol, alkanol amide, sodium hydroxide, glycol ester, or a mixture thereof.

In one aspect, the chemical solution comprises anionic surfactant, ethanol amine and butyl glycol.

Preferably, the concentration of the surfactant ranges from 0.05 to 2 wt%, of alkanol amide ranges from 0.1 to 1 wt%, of ethanol amine ranges from 0.1 to 1 wt%, of sodium hydroxide ranges from 0.1 to 1 wt%, and of glycol ester from 0.5 to 5 wt%.

In one preferred embodiment, the body is washed by means of longitudinally displaceable spray devices. The body is preferably washed by two lower spray devices, each lower spray device being disposed at a different side and having a predetermined transversal spacing therefrom, and by an elevated spray device. Each spray device is preferably guided along a corresponding track and is displaced a length equal to at least the

length of the body during a time interval equal to a corresponding predetermined period of time.

In a second preferred embodiment, the body is washed by a plurality of stationary spray devices. Each spray device is preferably disposed at a predetermined transversal spacing from the body. The number of spray devices preferably corresponds to the length of the body.

Brief Description of the Drawings

In the drawings:

- Fig. 1 is a front view of a spray device, in accordance with one preferred embodiment of the present invention;
- Fig. 2 is a side view of a controllable mist stream generated with the use of the present invention which is directed at a target location, wherein Fig. 2A illustrates a non-elevated spray device and Fig. 2B illustrates an elevated spray device;
- Fig. 3 is a photograph of a mist stream in accordance with the present invention;
- Fig. 4 is a side view of nozzle in accordance with the present invention, wherein Fig. 4a shows the employment of four nozzles and Fig. 4b shows the employment of one nozzle;
- Fig. 5 shows an arrangement in which a plurality of spray devices are employed;
- Fig. 6 is a schematic diagram of another preferred embodiment of the present invention in which a control valve is used to regulate the inflow of liquid into a spray device;
- Fig. 7 is a schematic diagram of another preferred embodiment of the invention in which a single control valve and sensor are used;
- Fig. 8 is a schematic diagram of yet another preferred embodiment in which a controller and a plurality of sensors are employed to control the inflow of water into a spray device;

- Fig. 9 is a schematic diagram of another preferred embodiment in which a controller controls the actuation of a plurality of control valves;
- Fig. 10 is a schematic diagram of an additional embodiment of the present invention in which a controller controls the inflow of water into a plurality of sectors of spray devices from separate lines of liquid;
- Fig. 11 illustrates one preferred embodiment of washing a motor vehicle with spray devices of the present invention;
- Fig. 12 illustrates another preferred embodiment of washing a motor vehicle with spray devices of the present invention; and
- Fig. 13 illustrates a nozzle unit with a plurality of inlets and corresponding sets of nozzles.

Detailed Description of Preferred Embodiments

Fig. 1 illustrates a spray device, generally designated by item 10, which comprises conventional fan 12 and nozzle unit 15 centrally mounted on the downstream side of grille 16 provided with fan 12. Water, or any other desired liquid, flows through hose 18 from check valve 14 into nozzle unit 15, whereupon a spray of liquid is discharged through each nozzle 20. The water particles which are discharged from nozzles 20 form a mist having a definite and controllable stream diameter, whereby the mist may be directed to a desired location upon entrainment within the air stream generated by fan blades 22. The direction of the stream of mist may be modified by adjusting the inclination of fan housing 8 with respect to fan support 9.

As seen in Fig. 2A, mist stream 25 generated by spray device 10 has the properties of a beam, namely it has a measurable starting diameter d and a measurable ending diameter D, greater than the starting diameter, after being directed a predetermined distance L at an angle of A relative to a

horizontal plane. Starting diameter d is approximately equal to the diameter of a circle formed by the plurality of nozzles radiating from nozzle unit 15. The discharge of nozzle unit 15 is released into the vacuum which is formed at the upstream side of air stream 26, corresponding to the location of the fan motor (not shown). The droplets that are discharged from nozzle unit 15 are not able to be randomly dispersed because of the pressure and turbulence of air stream 26 produced by fan blades 22, which flows over mist stream 25 and confines the latter to a limited diameter. Mist stream 25 is thereby propelled downstream and entrained within air stream 26. Since the beam-like nature of mist stream 25 is retained over the length of distance L, mist stream 25 may be accurately directed to a target location, e.g. the body of cow 28. Angle A can be adjusted by changing the inclination of the fan housing with respect to the fan support. Spray device 10 may be placed on the floor as shown, or may be elevated as shown in Fig. 2B, e.g. attached to post 23, and positioned such that mist stream 25 is directed at cow 28.

The spray device may be advantageously employed indoors or outdoors. When used in an unenclosed area, it is preferable to orient the spray device in such a position that the mist stream flows in a similar direction as the wind, in order to avoid mist stream stagnation.

A photograph of a controllable mist stream is shown in Fig. 3. The mist stream is shown as being white in contrast to the black background. The lateral dimension of the mist stream is shown to progressively increase from a location corresponding to the immediate discharge of the nozzle unit to a distance downstream thereof.

The size of ending diameter D is dependent upon several parameters: starting diameter d, distance L, the spray angle, diameter of fan blades, velocity of air stream 26 (or equivalently rotational speed of fan blades 22)

and density of the liquid that is propelled by the air stream. By increasing the value of any one of these parameters, without changing the value of the other parameters, ending diameter D will be larger. Thus mist stream 25 can be controlled in terms of its size, direction and target distance by varying one or more of the aforementioned parameters as a result of design constraints. The concentration of droplets within the mist stream is dependent upon the size of each droplet and the flow rate of the liquid within the inlet to nozzle unit 15. The size of each droplet in turn is a function of the outlet size of the nozzle.

Nozzle unit 15 is shown in Fig. 4a and is hollow with a cylindrical configuration, having a length greater than its outer diameter. Flange 30 is used to mount the nozzle unit to the grille of the fan, e.g. by screws, by bonding or by a spring lock. A plurality of apertures, e.g. four, are bored into fillet 31, the surface at which circumference 33 and front face 34 of the nozzle unit meet. Each nozzle 20, which is preferably flexible and is by example of the hollow cone type, is insertable within a corresponding aperture by a press fit. Spray angle S, which is the angle of each nozzle 20 with respect to the longitudinal axis of the nozzle unit, ranges from 0-75 degrees, and is preferably 45 degrees so as to provide a maximum starting diameter of the mist stream without resulting in dispersion thereof. Nozzle capacity of 5-50 liter/hr is sufficient for effective performance of the spray device according to the present invention.

When needed, such as when clogged, nozzle 20 may be removed and replaced. The nozzle unit, as well as the conduits through which the liquid to be sprayed flows, may be occasionally cleaned, e.g., by circulating an acidic liquid, such as vinegar or any other commercial acid, therethrough. The acid is introduced into the nozzle unit by a dosing pump and is circulated at a concentration of 5-20%, depending on the hardness of the water.

Hose 18 is insertable within an aperture formed in circumference 33 and secured thereto. Liquid which flows within the hose is injected into nozzle unit 15 and is provided with centrifugal motion therewithin, such that when discharged from nozzle 20 forms conical spray pattern 36. The discharges from each nozzle converge slightly downstream to form mist stream 25 (Fig. 2). In this configuration, the size of each water droplet is on the order of 100 microns, and a typical size of the outlet diameter is 10.7 mm.

Alternatively, as shown in Fig. 4b, a single nozzle 37 may be inserted within front face 34 of nozzle unit 15, such that the spray angle is approximately 0 degrees with respect to the longitudinal axis of the nozzle unit. In this configuration, the size of each water droplet is on the order of a fraction of a millimeter, and a typical size of the outlet diameter is 2 mm. Conical spray 38 produces a spray with a larger dispersion than conical spray 36 so that the starting diameter of the mist stream is as large as possible, e.g. 10 mm, with effective usage of liquid.

Hereinafter, for purposes of description, reference will be made to cows as the target of the spray device and water as the liquid to be sprayed, but this should be understood to be a preferred example and not a limitation since this invention is suitable for the spraying of any liquid at any suitable targets such as overheated bears enclosed within a cage at a zoo or any other overheated animal, cars to be washed, textile fibers to be sprayed before processing, the enclosure of a greenhouse for increasing the moisture content thereof and for the application of insecticide to plants grown therein, etc.

Optimal cooling of cows will take place when the mist stream is produced intermittently. By closing the water inlet to the nozzle unit, cows will not

be over-wet and water will be conserved. After a cow is wetted and the water inlet is closed, the air stream continues to flow so as to continue water evaporation and cooling from the cow. Check valve 14 (Fig. 1) may be employed during the cyclic operation of spray device 10, to ensure that water is readily available upstream of nozzle unit 15 and that a mist stream may therefore be immediately produced on demand.

To properly cool cows that are generally interspersed throughout a large area, namely in the feeding area, corral and waiting pen, a plurality of spraying devices need to be employed, each of which directs a controllable mist spray to a different location. An arrangement is shown in Fig. 5, in which a plurality of nozzle units 15, each of which is mounted on a different fan, receive water from a common water line 40 and discharge a spray from nozzles 20. Water line 40 subdivides into branches 41, such that each branch 41 supplies water to a corresponding spray device 10. The flow of water into water line 40 is regulated by valve 43.

Another preferred embodiment of the spray device is illustrated in Fig. 6. The flow of water into nozzle unit 15 is regulated by control valve 45, so that water at a predetermined pressure is admitted therein for a predetermined duration. Timer 48 communicates with actuator 46, e.g. a solenoid actuator, of the control valve in order to maintain the cyclic operation of the spray device. After discharging a mist stream for a predetermined duration, timer 48 transmits a signal to close control valve 45, so that the air stream generated by the corresponding fan flows without propelling a mist stream. After a second predetermined duration, timer 48 transmits a signal to open control valve 45 again and to therefore generate a mist stream.

Another preferred embodiment of the spray device is illustrated in Figure 7. Spray device 50 includes controller 53, control valve 45 and singular

sensor 57. Water flows into water line 32, after shutoff valve 43 has been opened, through control valve 45, when the control conditions enable such a flow as detailed hereinafter, and is injected into nozzle unit 15. Sensor 57 detects the ambient temperature and communicates with controller 53. Controller 53 in turn communicates with control valve actuator 46. When the sensed ambient temperature becomes greater than a predetermined low switch point, controller 53 commands control valve 45, by means of actuator 46, to allow water inflow. Similarly when the sensed ambient temperature becomes less than a predetermined high switch point, control valve 45 is commanded to prevent water inflow into nozzle unit 15. Alternatively, sensor 57 can be operative to sense the ambient wind velocity, such as an anemometer, wind vane or digital wind sensor. In conjunction with such a sensor, controller 53 commands control valve 45 to allow water inflow into nozzle unit 15 as the wind velocity is less than a predetermined value and to prevent water inflow as the wind velocity is greater than a predetermined value. Sensor 57 may also be a hygrometer, or any other instrument to sense the relative humidity. A mist stream will not enhance the cooling of a cow if the relative humidity is above a certain value since the entrained water particles will not be able to evaporate. It is advisable in such meteorological conditions to prevent the generation of a mist stream by closing control valve 45.

Controller 53 may also advantageously control the operation of fan 12. In response to one of the aforementioned types of sensors, controller 53 may control the operation of fan 12, i.e. activation/deactivation and rotational speed of the fan blades, by means of fan motor actuator 59, depending upon the value of the parameter sensed by sensor 57. Controller 53 commands the closing of control valve 45 shortly before deactivating the fan motor, so as not to cause any collection of water in the vicinity of the spray device, resulting from the discharge of water from nozzle unit 15 that does not form a mist stream. However, the fan motor can operate

even though control valve 45 is closed, to provide a cooling effect by an air stream during a marginally warm day when a mist stream is not necessary, or alternatively during a very humid day when a mist stream is not helpful.

As shown in Fig. 8, spray device 50 may be provided with more than one sensor. Two sensors 57a and 57b are illustrated, but any other number nay be conveniently employed. Each sensor may be of a different type. For example, sensor 57a may be a hygrometer and sensor 57b may be a temperature sensor, since there is a need to generate an air stream without a mist stream during conditions of high humidity only when the ambient temperature is higher than a predetermined value. The set points and the sensitivity of each sensor are preferably determined in accordance with the selected design constraints. Controller 53 acquires the data input from each sensor, compares the relative values, processes the information, commands the actuator of control valve 43 to regulate the inflow into nozzle unit 15 and commands actuator 59 to control the operation of fan 12.

The construction of controller 53 is of course dependent upon the particular type of sensor used, as will be apparent to the skilled person. The controller, in a particular embodiment of the invention, comprises four sub-units: a microprocessor, software for programming actuators 46 and 59 in a preferred manner (which may, of course, be implemented by hardware), a local memory and a means of communicating with the actuators and sensors. These sub-units will also be easily apparent to the skilled person, and are therefore not described herein in detail, for the sake of brevity.

As is well known, a control valve is actuatable to admit a predetermined amount of water at a predetermined flow rate. Controller 53 receives input

from sensors 57a and 57b via cable 60, or alternatively in wireless fashion, and in accordance with a predetermined program, and commands control valve actuator 46 to deliver water at a preferred pressure and flow rate and for a predetermined duration, depending on the input signals from the sensors, so that a preferred arrangement of the mist stream may be produced and efficient usage of water may be effected.

Fig. 9 illustrates another preferred embodiment in which controller 65 controls the actuation of a plurality of control valves 68. Each control valve 68 admits the inflow of water into the corresponding spray device 70, 71 and 72. The sensors of each set of containers communicate with controller 65, which determines, as a result of a selected program, whether a mist stream is to be produced, and if so, initiates a command to the corresponding control valve actuator to admit an additional amount of water. Preferably each control valve 68 admits water to the corresponding spray device at a different time, so that water at the optimal flow rate and pressure will be admitted thereto. If extenuating circumstances dictate that water has to be admitted to several sets of containers simultaneously, controller 65 commands the actuators to approximate the preferred operating conditions as much as possible. Of course, controller 65 also controls the operation of the corresponding fan motor, as described hereinbefore.

Fig. 10 illustrates another embodiment wherein controller 65 commands the actuation of two separate control valves 80 and 81, through which water flows from two separate water lines 83 and 84, respectively. With this configuration the water flow rate and pressure is sufficient to provide water for the spray devices of each sector 86, so that a mist stream may be directed at a target location separated a predetermined distance from the corresponding spray device. Each sector is comprised, for example, of four spray devices 88.

Figs. 11-13 illustrate another application of the spray device according to the present invention, namely the washing of a motor vehicle. The following description refers to the washing of a car, but it would be appreciated that it is equally advantageous to employ the present invention for the washing of any motor vehicle, such as a truck or a bus.

As shown in Fig. 11, car 90 is washed by means of longitudinally displaceable, i.e. in a direction toward the front and alternately to the rear of the car, spray devices 92 and 95. Two lower spray devices 92 are provided and are transversely spaced, i.e. in a direction perpendicular to the longitudinal direction, from each side of the car, respectively. The transversal spacing is selected so that the diameter of mist stream 91 is sufficiently large so as to be capable of moistening the entire height of car 90. The height of elevated spray device 95 is selected to allow for the moistening of the hood, as well as the front and rear windows.

Each spray device 92 is guided along a corresponding track 94. For example, the leg portion of the spray device is provided with a horizontal protrusion 95 that is insertable within, and engageable with, a recess formed within the track. A drive means (not shown) longitudinally displaces spray device 92 at a controlled rate, such that the spray device is displaced a length equal to at least the length of the car during a time interval equal to a predetermined period of time. As a result, the entire side of the car is moistened by mist stream 91 during the predetermined period of time. Likewise elevated spray device 95 is provided with a pair of guides 98 for engagement with track 96 and is displaceable by a corresponding drive means (not shown).

In order to effectively wash the car, the spray devices discharge a spray of different liquids in accordance with a predetermined cycle. After

generating an air stream by a fan, or alternatively by any other feasible means such as a duct or a wind tunnel, the spray devices discharge a fine mist stream in order to moisten any dirt particles that have accumulated on the car body. A chemical solution is then admitted to the nozzle unit (Fig. 13), whereupon a mist stream comprising water and the chemical solution is propelled by the air stream and impinges upon the car. A foam is produced by the chemical solution and remains on the car body for a sufficient time which facilitates the dissolving of the dirt particles. The cleaning capability of the foam is enhanced by deactivating the air generating means and by preventing the flow of water and of the chemical solution. The car is then washed with a high-pressure mist stream, after which the water inlet is closed and the remaining water is dried by the air stream.

The chemical solution preferably is an aqueous solution comprising a compound selected from the group of surfactant, aliphatic alcohol, aminoalcohol, alkanol amide, sodium hydroxide, glycol ester, or a mixture thereof, for the production of a foam that facilitates the dissolving of dirt particles.

The car washing cycle may alternatively include a step of applying a mist stream of wax after the chemical solution is washed by the high-pressure stream. The wax remains on the car for a period of time, and then is dried by the air stream.

Car 90 may also be washed by a plurality of stationary spray devices, as illustrated in Fig. 12. Two lower spray devices 92 are provided at each side of the car, while each lower spray device is disposed at a predetermined transversal spacing therefrom so as to maximize the surface area being impinged by the given mist stream. The number of lower spray devices 92 that are employed preferably corresponds to the length of the car. Likewise

at least one elevated spray device 95, and preferably two, are located at a sufficient distance from the car and are positioned at such an angle so as to impinge upon those sections of the car that are beyond the range of lower spray devices 92.

As shown in Fig. 13a, nozzle unit 101 has three separate inlets 102, 103 and 104 with three corresponding liquid circulation chambers (not shown) and three corresponding sets of nozzles 108, 109 and 110, respectively. For example, nozzles 108 are adapted for the low-pressure mist stream of water, nozzles 109 for the mist stream of chemical solution and nozzle 110 for the high-pressure mist stream of water. Another nozzle may be positioned next to nozzle 110 for the discharge of wax.

Example 1

Cooling of Cows

A nozzle unit having four nozzles is employed. Each nozzle is equidistantly spaced from an adjacent nozzle and disposed at a spray angle of 45 degrees. The diameter of a circle formed by the nozzles is 10 cm. An exemplary nozzle is the Dan Fogger 7800, manufactured by Dan Sprinklers Ltd., Israel.

The fan that generates the air stream is Model Z-A, manufactured by Ziehl-Abegg, Germany. The diameter of the fan blades is 50 cm and the velocity of the air stream is 7 m/sec at an operating speed of 1400 rpm. With a water pressure of 4 atmospheres, a mist stream is produced having an ending diameter of 4 meters at a distance of 10 meters from the nozzle unit. With a fan blade diameter of 63 cm and an air stream velocity of 7 m/sec at an operating speed of 900 rpm, a mist stream is produced having an ending diameter of 6 meters at a distance of 12 meters from the nozzle unit. With a fan blade diameter of 63 cm and an air stream velocity of 9 m/sec at an operating speed of 1400 rpm, a mist stream is produced having

an ending diameter of 7 meters at a distance of 16 meters from the nozzle unit.

Example 2

Cooling of Cows with Multiple Spray Devices

Each nozzle unit is provided with four nozzles having a spray angle of 45 degrees. The effective diameter of the nozzles is 10 cm. The inflow to each nozzle unit is regulated by a separate control valve.

Three elevated fans at a height of 3 meters are used, with one nozzle unit on each fan. One fan having a blade diameter of 63 cm is located in the waiting yard of the dairy farm and is operated at a rotational speed of 1400 rpm. A mist stream is produced having an ending diameter of 7 meters at a distance of 16 meters from the nozzle unit through which water flows at 28 L/hr. The second fan, which is located in the feeding area, has a blade diameter of 50 cm and is operated at a rotational speed of 1400 rpm. A mist stream is produced having an ending diameter of 4 meters at a distance of 12 meters from the nozzle unit through which water flows at 28 L/hr. The third fan, which is located in the corral, has a blade diameter of 63 cm and is operated at a rotational speed of 900 rpm. A mist stream is produced having an ending diameter of 6 meters at a distance of 14 meters from the nozzle unit through which water flows at 7 L/hr.

The three spray devices communicate with a common controller, such that the mist stream of each corresponding spray device is generated for a duration of 0.5 minutes once in five minutes in response to a main timer.

Example 3

Spraying of perfume

Perfume at a concentration of 2% with a trade name "Fragrancs," manufactured by Frutarom Ltd., Israel, having a density of 0.9 gm/ml is sprayed within a wedding hall having an area of 100 m^2. 6 spray devices are employed, and each spray device is provided with a nozzle unit having 4 nozzles. Each nozzle is equidistantly spaced from an adjacent nozzle and disposed at a spray angle of 45 degrees. The effective diameter of the nozzles is 10 cm. A fan having a blade diameter of 50 cm is constantly operated at a rotational speed of 1400 rpm. A mist stream is produced having an ending diameter of 7 meters at a distance of 12 meters from the nozzle unit. The perfume flows at a pressure of 2 atmospheres and the particles which are discharged from the nozzle unit have a mean diameter of a fraction of a millimeter.

Example 4

Car Washing

Two displaceable lower spray devices positioned at a height of 0.5 meters above ground level are used at a relative transversal spacing of 6 meters, one on each side of the car. The fans of lower spray devices have a blade diameter of 630 mm and are operated at 900 rpm. One displaceable elevated spray device at a height of 4 meters is used, and its fan having a rotational speed of 1400 rpm is provided with a blade diameter of 500 mm. Each nozzle is equidistantly spaced from an adjacent nozzle and disposed at a spray angle of 45 degrees. The diameter of a circle formed by the nozzles is 10 cm.

The chemical solution, which is delivered to the nozzle unit at a flow rate of 7 liters/hr is "Zohar Car Foamer" manufactured by Zohar Ltd., Israel with a viscosity of 5 cp and is diluted at a concentration of 5%. This solution comprises anionic surfactant, ethanol amine and butyl glycol.

A mist stream of water is produced for 1 minute, then a mist stream of chemical solution is produced for 0.5 minute, then the foam remains for 5 minutes on the car without any air stream or mist stream, then a water stream having pressure of 7 atmospheres is delivered at a flow rate of 28 liters/hr for 2 minutes and finally the water is dried by an air stream for five minutes. A KP 60/12 M pump, manufactured by Viking Pump, Inc. USA is used to deliver the chemical solution and high-pressure water. A microprocessor-based controller is used to synchronize the operation of each spray device and of the various motors which longitudinally displace each corresponding spray device, in order to wash a car according to the aforementioned cycle.

While some embodiments of the invention have been described by way of illustration, it will be apparent that the invention can be carried into practice with many modifications, variations and adaptations, and with the use of numerous equivalents or alternative solutions that are within the scope of persons skilled in the art, without departing from the spirit of the invention or exceeding the scope of the claims.

CLAIMS

1. A spray device, comprising a means for generating an air stream having a predetermined velocity and a nozzle unit with at least one inlet for the introduction therein of a liquid and a separate set of nozzles corresponding to each of said inlets for the discharge of liquid therefrom, said nozzle unit fixedly attached to the central portion of said air stream generating means, such that said discharged liquid is entrainable by said air stream whereby to produce a mist stream capable of being propelled to a predetermined location, said mist stream having a measurable and controllable lateral dimension at said predetermined location.

2. Spray device of claim 1, wherein the nozzle unit possesses a low profile.

3. Spray device of claim 1, wherein the air stream generating means is a fan having blades and a guard grille, the nozzle unit being centrally mounted on the downstream side of the grille and the blades defining a blade diameter.

4. Spray device of claim 3, wherein the nozzle unit comprises one or more nozzles essentially symmetrically positioned with respect to the center of the fan blades.

5. Spray device of claim 3, wherein the nozzle unit is essentially concentrical with the fan blades.

6. Spray device of claim 3, wherein the inclination of the fan with respect to a fan support is adjustable, the direction of the mist stream thereby being adjustable.

7. Spray device of claim 1, further comprising a check valve, said check valve being installed within each inlet to the nozzle unit.

8. Spray device of claim 1, wherein the nozzle unit is hollow with a substantially cylindrical, conical or pyramidal configuration.

9. Spray device of claim 8, wherein the nozzle unit is provided with at least one partition, thereby defining two adjacent liquid circulation chambers, wherein the liquid introduced through a corresponding inlet circulates through a corresponding chamber and is discharged through a corresponding set of nozzles.

10. Spray device of claim 3, wherein the length of the nozzle unit is greater than its outer diameter and a flange is used to mount the nozzle unit to the grille of the fan.

11. Spray device of claims 8 to 10, wherein the periphery of the nozzle unit are provided with a plurality of apertures, a nozzle being insertable within each aperture.

12. Spray device of claim 11, wherein each nozzle is equidistantly and circumferentially spaced from an adjacent nozzle, the maximum radial spacing between nozzles defining an effective diameter.

13. Spray device of claim 12, wherein the effective diameter of the nozzles is less than the blade diameter of the fan.

14. Spray device of claim 11, wherein the spray angle of each nozzle with respect to a longitudinal axis of the nozzle unit ranges from 0-75 degrees.

15. Spray device of claim 14, wherein the spray angle is substantially 45 degrees.

16. Spray device of claims 8 to 10, wherein a front face of the nozzle unit is formed with an aperture and a nozzle is insertable within said aperture, such that the spray angle of the nozzle is approximately 0 degrees with respect to the longitudinal axis of the nozzle unit.

17. Spray device of claims 8 to 16, wherein the capacity of each nozzle ranges from 5-50 liter/hr.

18. Spray device of claims 8 to 16, wherein each nozzle is removable and replaceable.

19. Spray device of claim 1, wherein the at least one liquid inlet is regulated by a control valve.

20. Spray device of claim 1, wherein each liquid inlet is regulated by a control valve.

21. Spray device of claims 19 or 20, further comprising a timer, said timer being capable of communicating with an actuator of the control valve, whereby to maintain a cyclic operation of the spray device.

22. Spray device of claims 19 to 21, further comprising a controller and sensor, said controller operative to regulate the control valve in response to a value relating to ambient conditions sensed by said sensor.

23. Spray device of claim 22, wherein the sensor is selected from the group of temperature sensor, humidity sensor and wind speed sensor.

24. Spray device of claim 22, wherein the controller is operative to control the operation of the air stream generating means.

25. A network of spray devices, each spray device being the spray device of claims 1 to 24.

26. Network of claim 25, wherein the inlet to the network is regulated by a control valve.

27. Network of claim 25, wherein the inlet to each spray device is regulated by a control valve.

28. Network of claim 27, wherein the controller regulates a plurality of control valves.

29. A method for directing a spray to a target location, comprising generating an air stream having a predetermined velocity, generating a spray of liquid, such that said spray of liquid is injected into said air stream and entrained thereby, whereby to produce a mist stream having a measurable and controllable thickness; and allowing said mist stream to be propelled by said air stream for a predetermined length so that at said target location the lateral dimension of said mist stream is substantially of a predetermined value.

30. Method of claim 29, wherein the air stream is generated by means of a fan having a grille and fan blades.

31. Method of claim 30, wherein the spray of liquid is generated by allowing a liquid having a sufficient flow rate to flow through a conduit and to be introduced into a nozzle unit which is mounted onto the grille of the fan, whereupon the liquid is discharged as a spray through each of a set of nozzles provided with said nozzle unit.

32. Method of claim 31, wherein each nozzle is disposed at a spray angle and sufficiently spaced from an adjacent nozzle to define an effective diameter of the nozzles.

33. Method of claim 31, wherein the discharges from each of the nozzles converge slightly downstream from the nozzle unit.

34. Method of claim 32, wherein the lateral dimension of the mist stream is controlled by modifying the value of at least one parameter selected from the group of effective diameter of the nozzles, distance to the target location, spray angle, diameter of fan blades, velocity of air stream and density of the liquid that is propelled by the air stream.

35. Method of claim 31, wherein the concentration of the mist stream is controlled by regulating the flow rate of the liquid to be sprayed and by changing the outlet size of each nozzle.

36. Method of claim 29, wherein the mist stream is used to cool overheated animals.

37. Method of claim 29, wherein the mist stream is used to wash cars.

38. Method of claim 29, wherein the mist stream is used to moisten textile fibers to be processed.

39. Method of claim 29, wherein the mist stream is used to provide a fragrance to a room.

40. A method of washing a body, comprising the following steps:

a) generating an air stream having a predetermined velocity;

b) providing a nozzle unit with a first inlet and a second inlet for the introduction therein of water and of a chemical solution, respectively, and a first and second sets of nozzles corresponding to said first and second inlets, water and said chemical solution being capable of circulating in separate chambers within said nozzle unit;

c) allowing water to flow into said first inlet;

d) allowing a spray of water to be discharged from said first set of nozzles, such that said spray of water is injected into said air stream and entrained thereby, whereby to produce a first mist stream having a measurable and controllable lateral dimension and allowing said mist stream to be propelled by said air stream for a predetermined length so that at said target location said first mist stream is capable of moistening dirt particles attached to the surface of a body;

e) after a first predetermined period of time, allowing said chemical solution to flow into said second inlet;

f) allowing a spray of chemical solution to be discharged from said second set of nozzles, such that said spray of chemical solution, together with said spray of water, is injected into said air stream and entrained thereby, whereby to produce a second mist stream having a measurable and controllable lateral dimension and allowing said second mist stream to be propelled by said air stream

for a predetermined length so that at said target location said second mist stream is capable of spraying said body and producing a foam thereon;

g) after a second predetermined period of time, preventing flow of said air stream, flow of water into said first inlet and of said chemical solution into said second inlet;

h) after a third predetermined period of time, repeating steps a)-d), water being introduced into said first inlet at a predetermined pressure;

i) after a fourth predetermined period of time, preventing flow of water; and

j) after a fifth predetermined period of time, transporting the washed body.

41. Method of claim 40, wherein the body is that of a motor vehicle.

42. Method of claim 40, wherein the body is an animal body.

43. Method of claim 40, wherein the first predetermined period of time is approximately 1 minute, the second predetermined period of time is approximately 0.5 minute, the third predetermined period of time is approximately 5 minutes, the fourth predetermined period of time is approximately 2 minutes and the fifth predetermined period of time is approximately five minutes.

44. Method of claim 40, wherein the predetermined pressure is approximately 7 atmospheres.

45. Method of claim 40, further comprising, after step i), providing said nozzle unit with a third inlet and a corresponding third set of nozzles, allowing a spray of wax to be discharged from said third set

of nozzles, and after a sixth predetermined period of time, preventing flow of wax.

46. Method of claim 45, wherein the sixth predetermined period of time is approximately 1 minute.

47. Method of claim 40, wherein the chemical solution is an aqueous solution comprising a compound selected from the group consisting of surfactant, aliphatic alcohol, aminoalcohol, alkanol amide, sodium hydroxide, glycol ester, or a mixture thereof.

48. Method of claim 47, wherein the chemical solution comprises anionic surfactant, ethanol amine and butyl glycol.

49. Method of claims 47 or 48, wherein the concentration of the surfactant ranges from 0.05 to 2 wt%, of alkanol amide ranges from 0.1 to 1 wt%, of ethanol amine ranges from 0.1 to 1 wt%, of sodium hydroxide ranges from 0.1 to 1 wt%, and of glycol ester from 0.5 to 5 wt%.

50. Method of claim 40, wherein the body is washed by means of longitudinally displaceable spray devices.

51. Method of claim 50, wherein the body is washed by two lower spray devices having a predetermined transversal spacing therefrom and by an elevated spray device.

52. Method of claim 50, wherein each spray device is guided along a corresponding track and is displaced a length equal to at least the length of the body during a time interval equal to a corresponding predetermined period of time.

53. Method of claim 40, wherein the body is washed by a plurality of stationary spray devices.

54. Method of claim 53, wherein each spray device is disposed at a predetermined transversal spacing from the body.

55. Method of claim 53, wherein the number of spray devices corresponds to the length of the body.

56. A spray device, substantially as described and illustrated.

57. A method for directing a spray to a target location, substantially as described and illustrated.

58. A method for washing a car, substantially as described and illustrated.

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LUZZATTO & LUZZATTO
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ARIEH JEHUDA POLAK

Fourteen Sheets of Drawings
Sheet No. 1

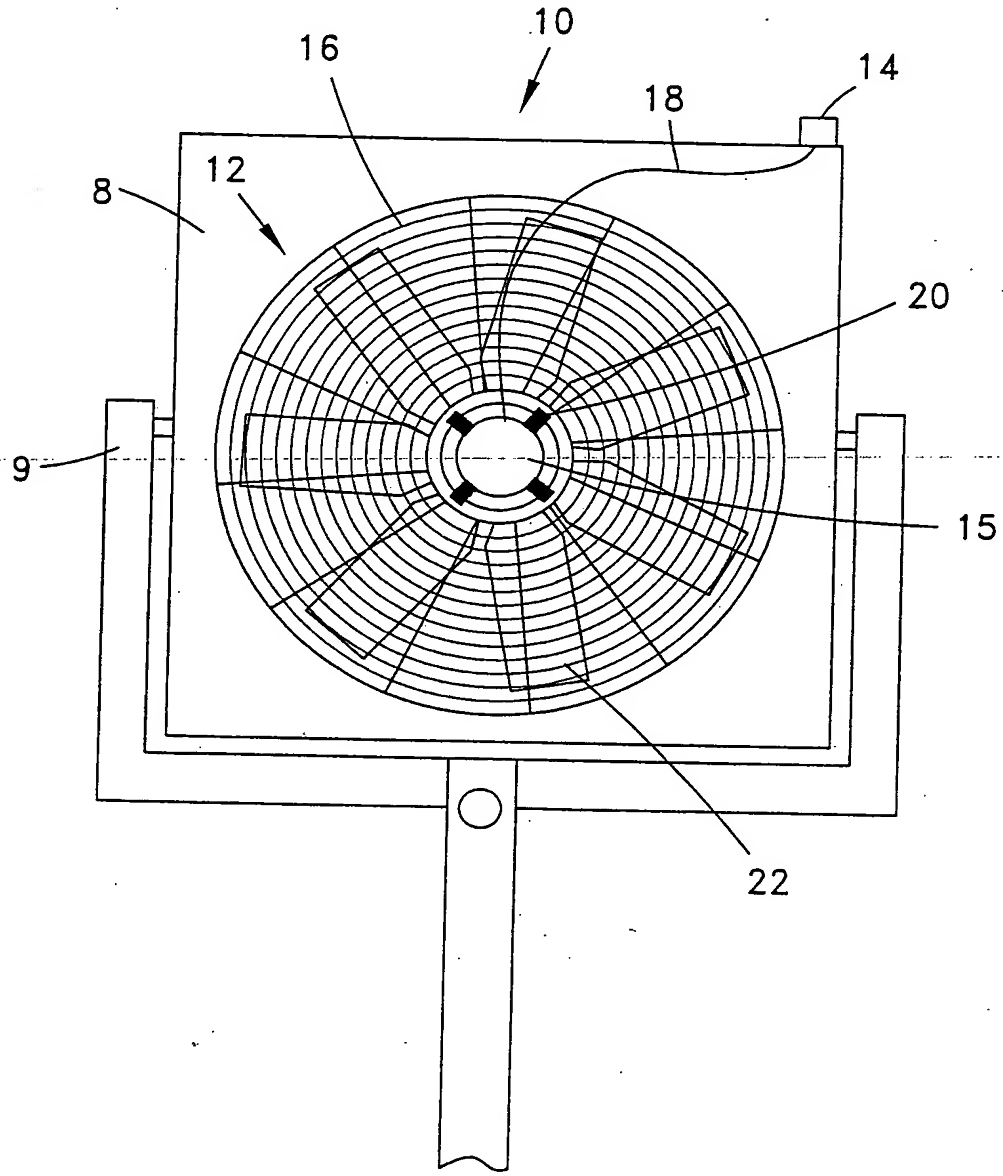

Fig. 1

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Sheet No. 2

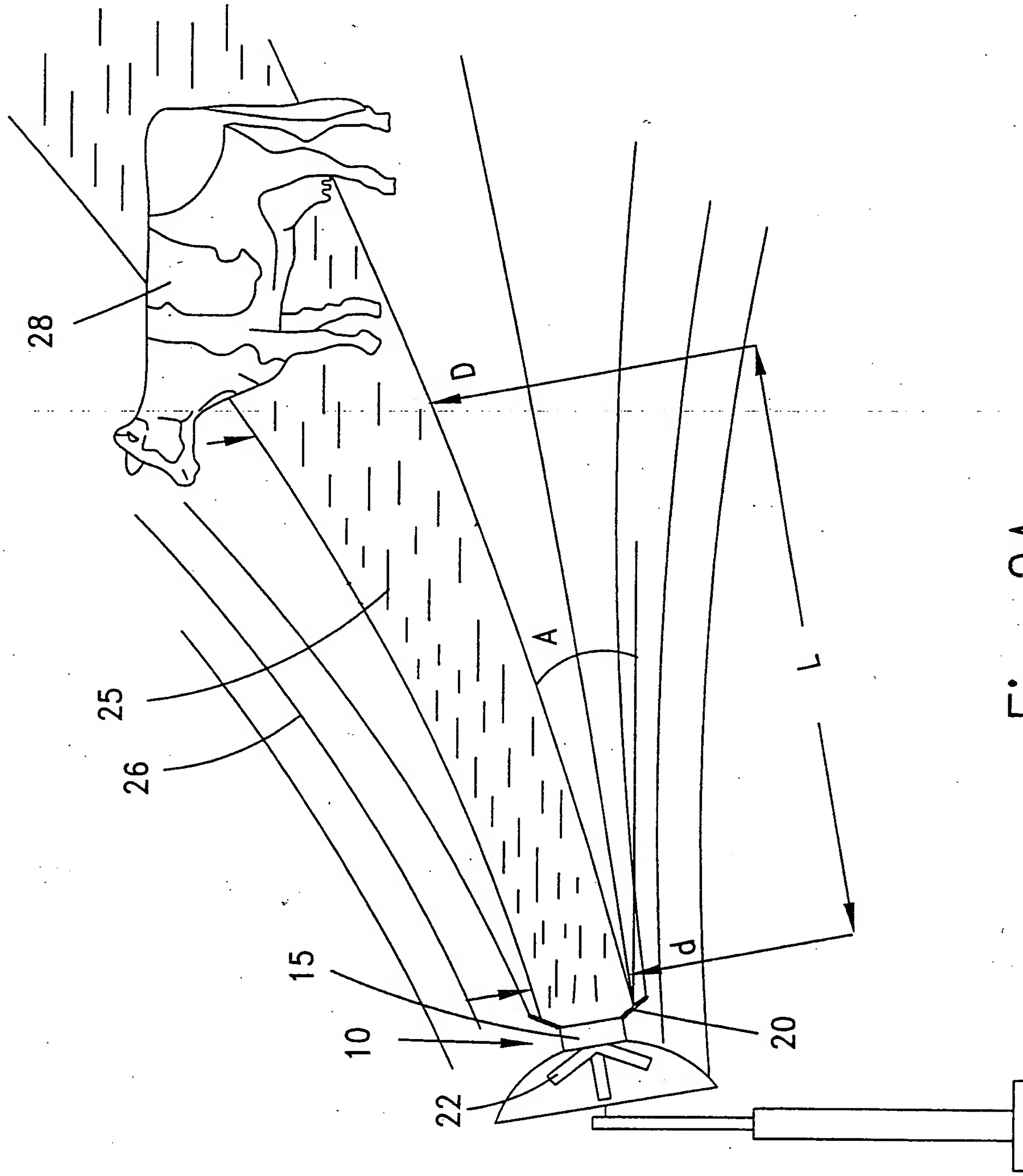

Fig. 2A

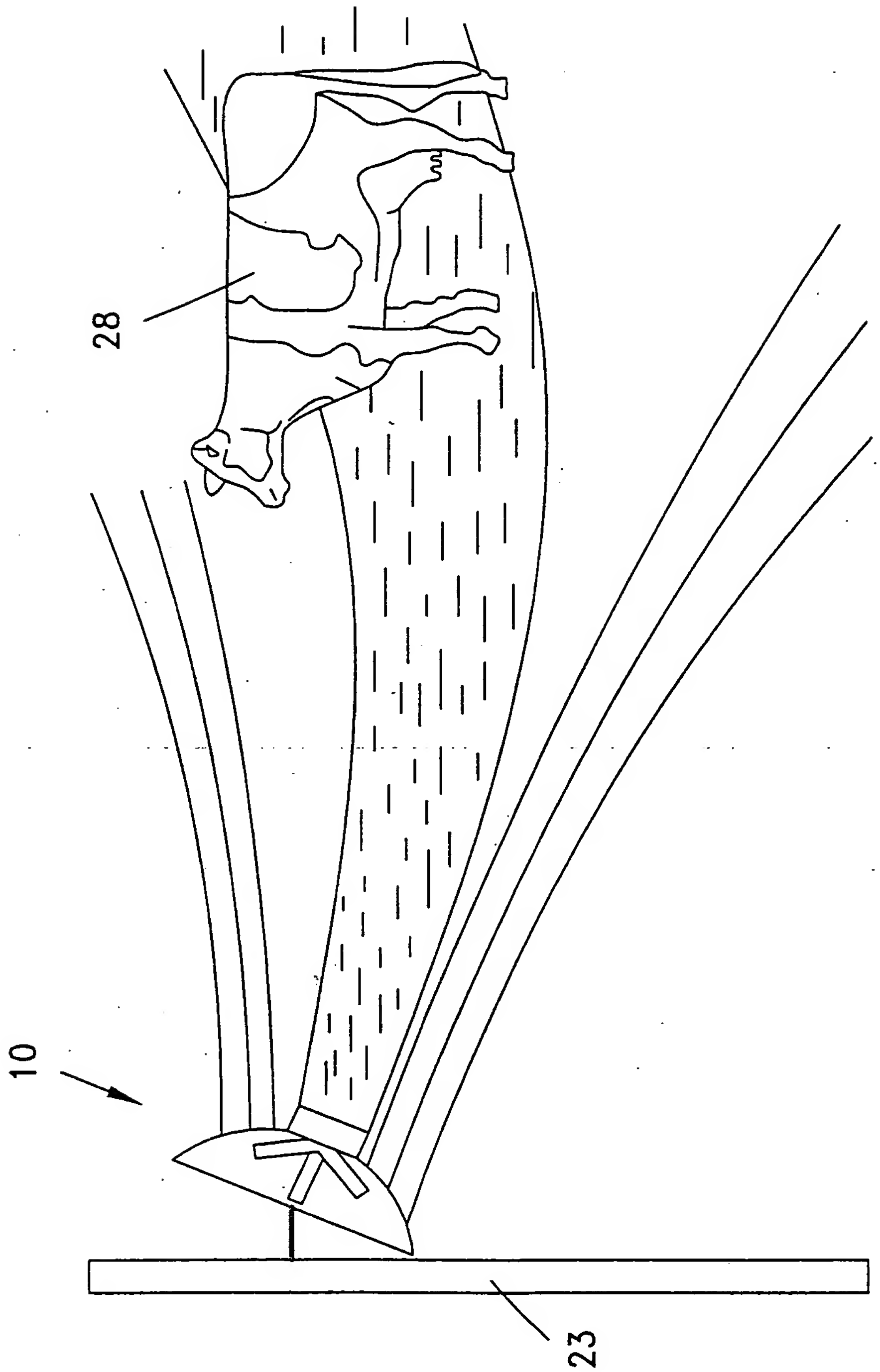

Fig. 2B

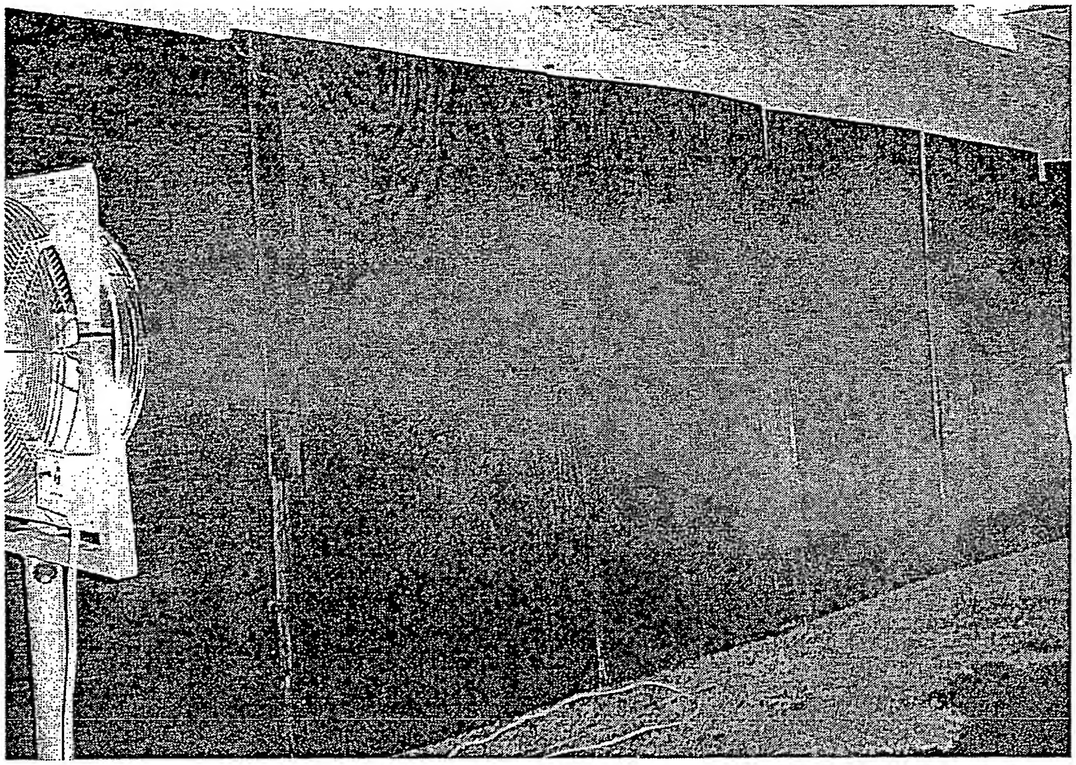

Fig. 3

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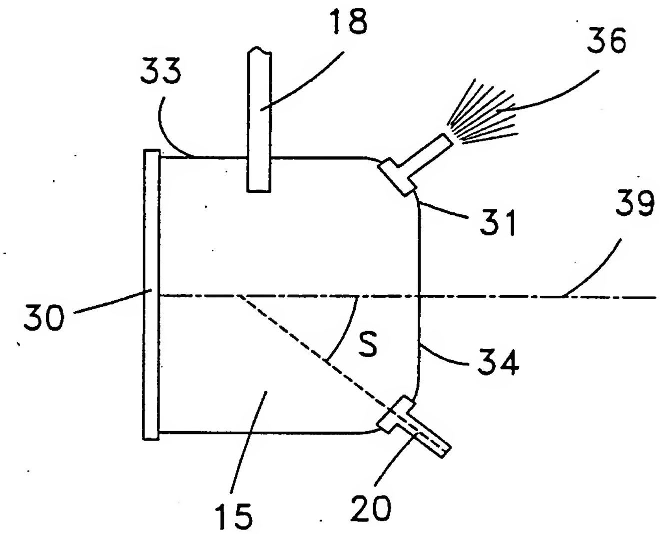

Fig. 4a

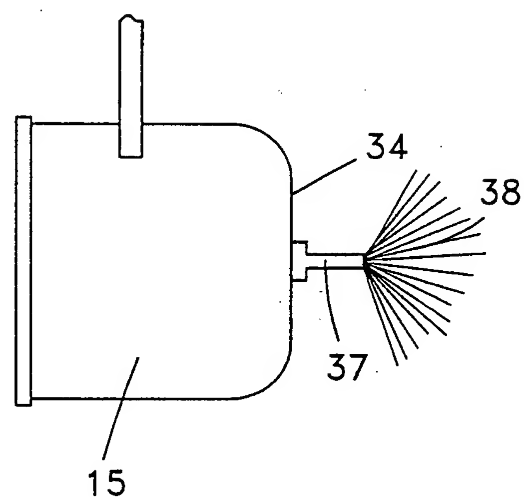

Fig. 4b

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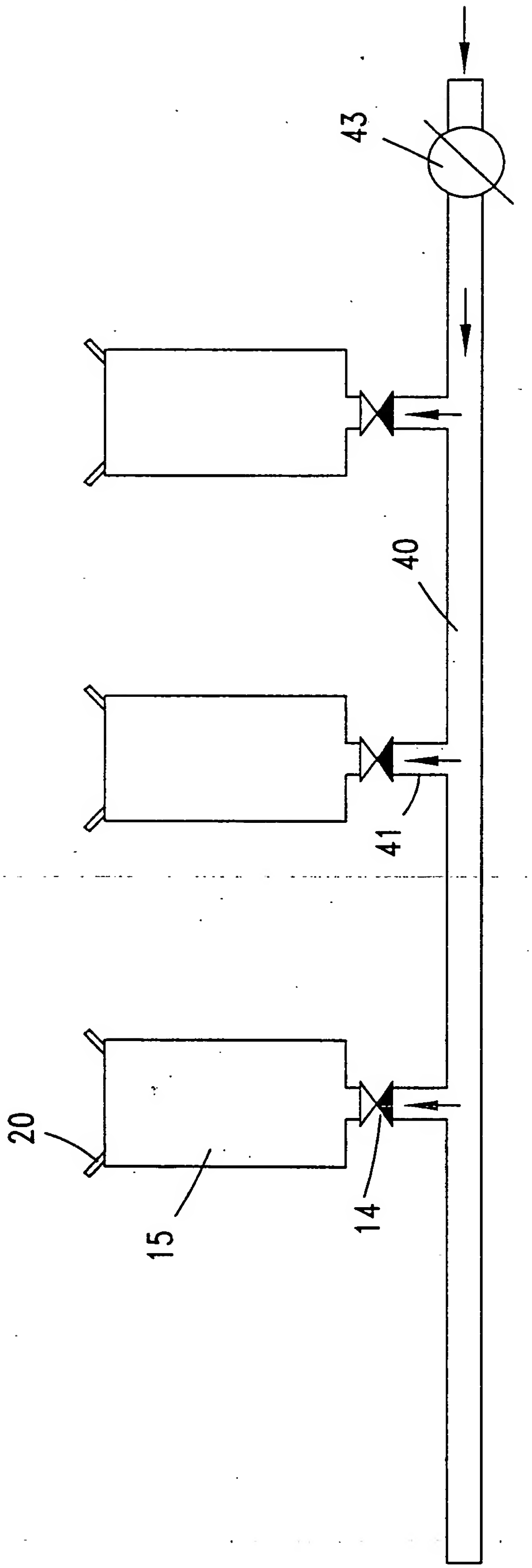

Fig. 5

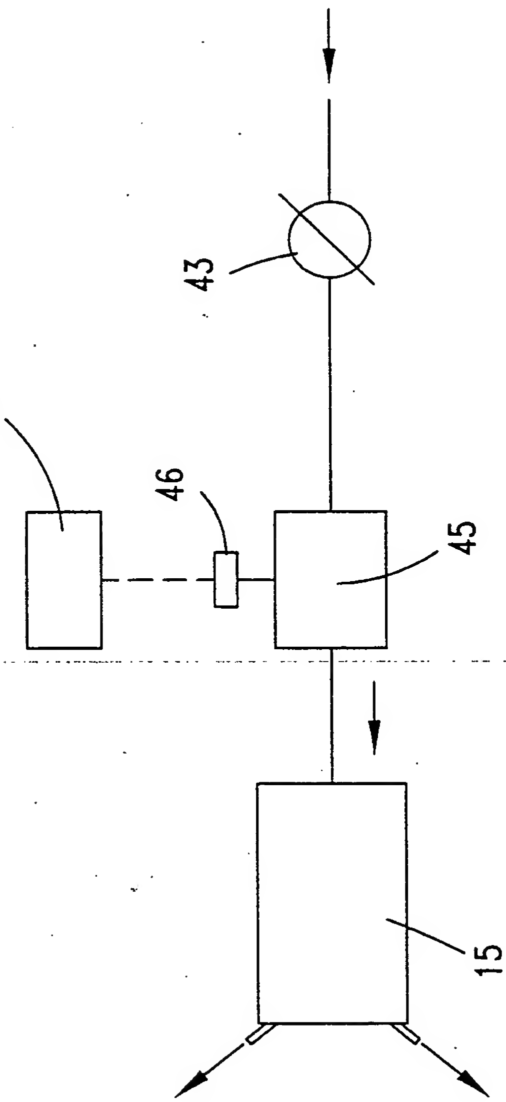

Fig. 6

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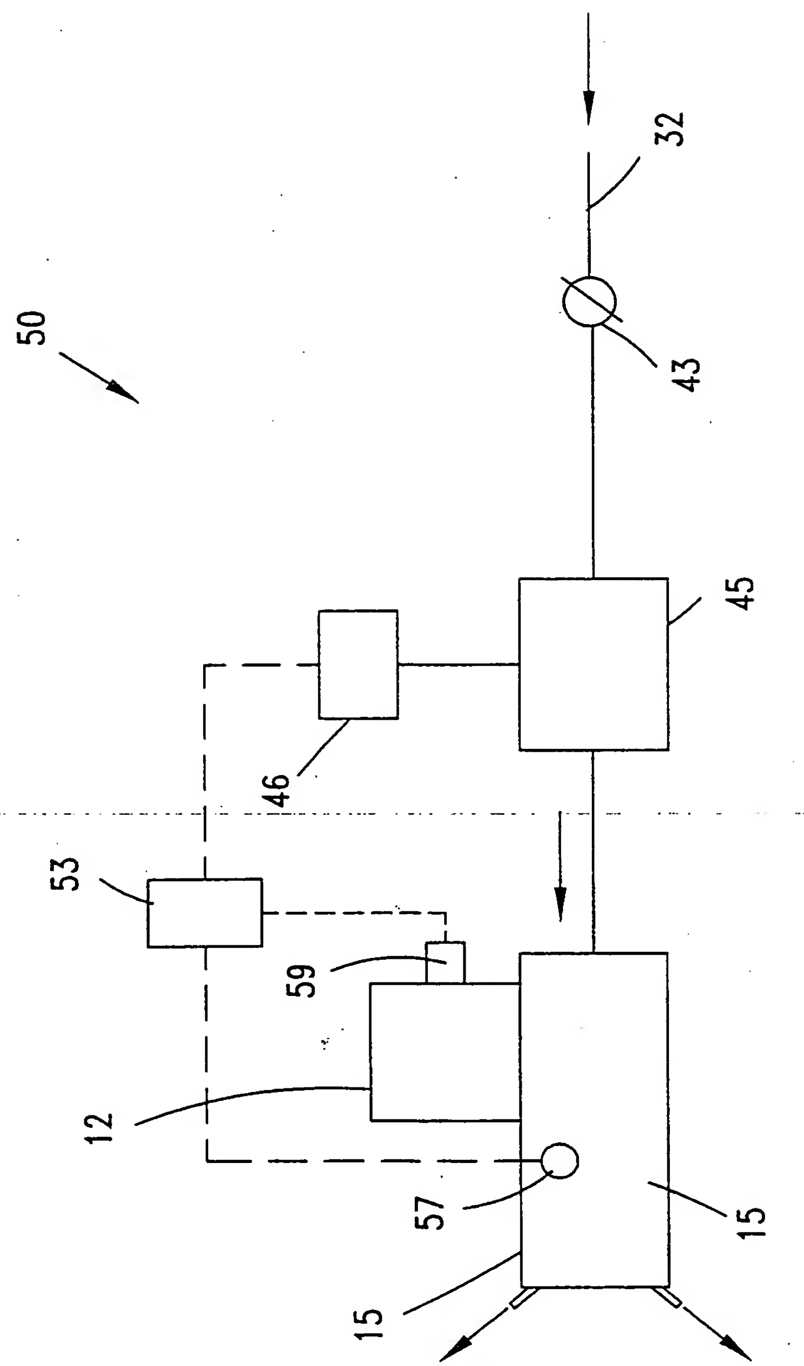

Fig. 7

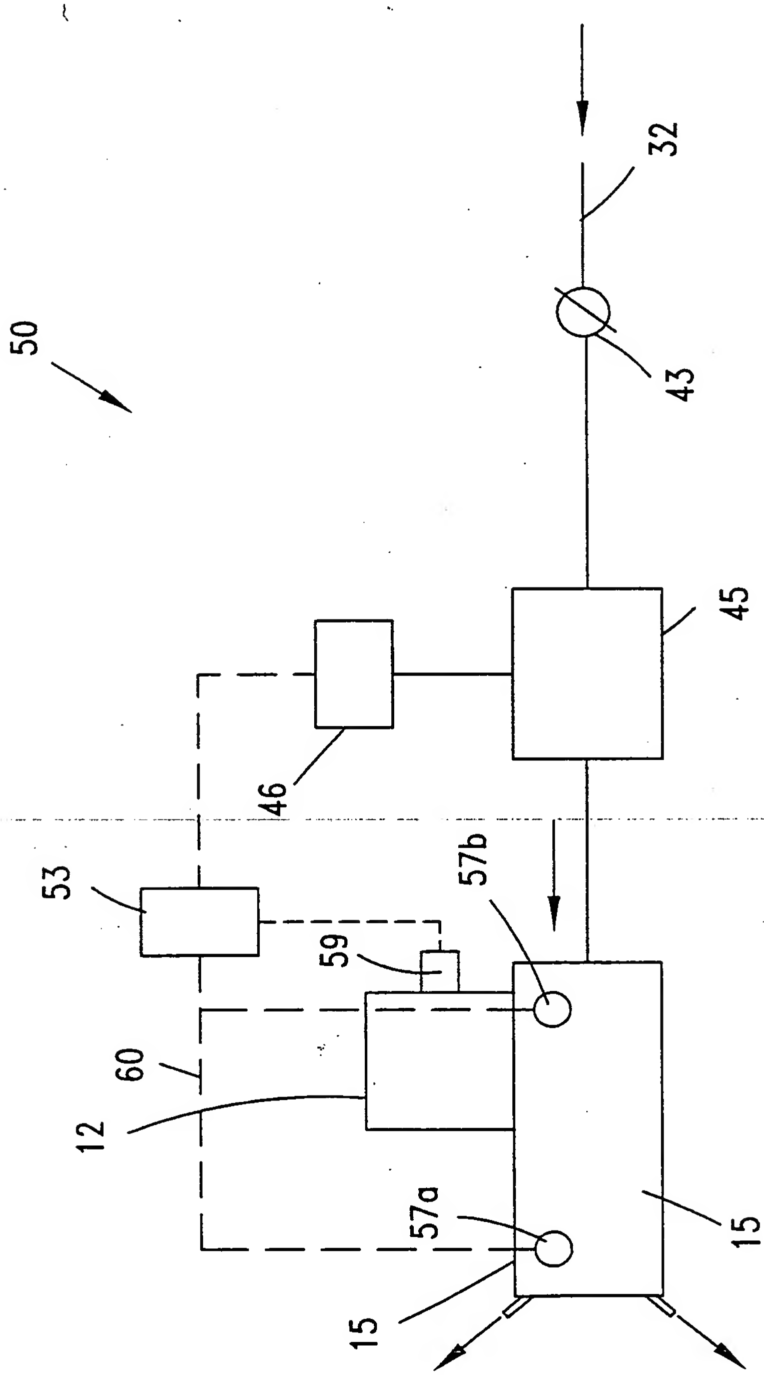

Fig. 8

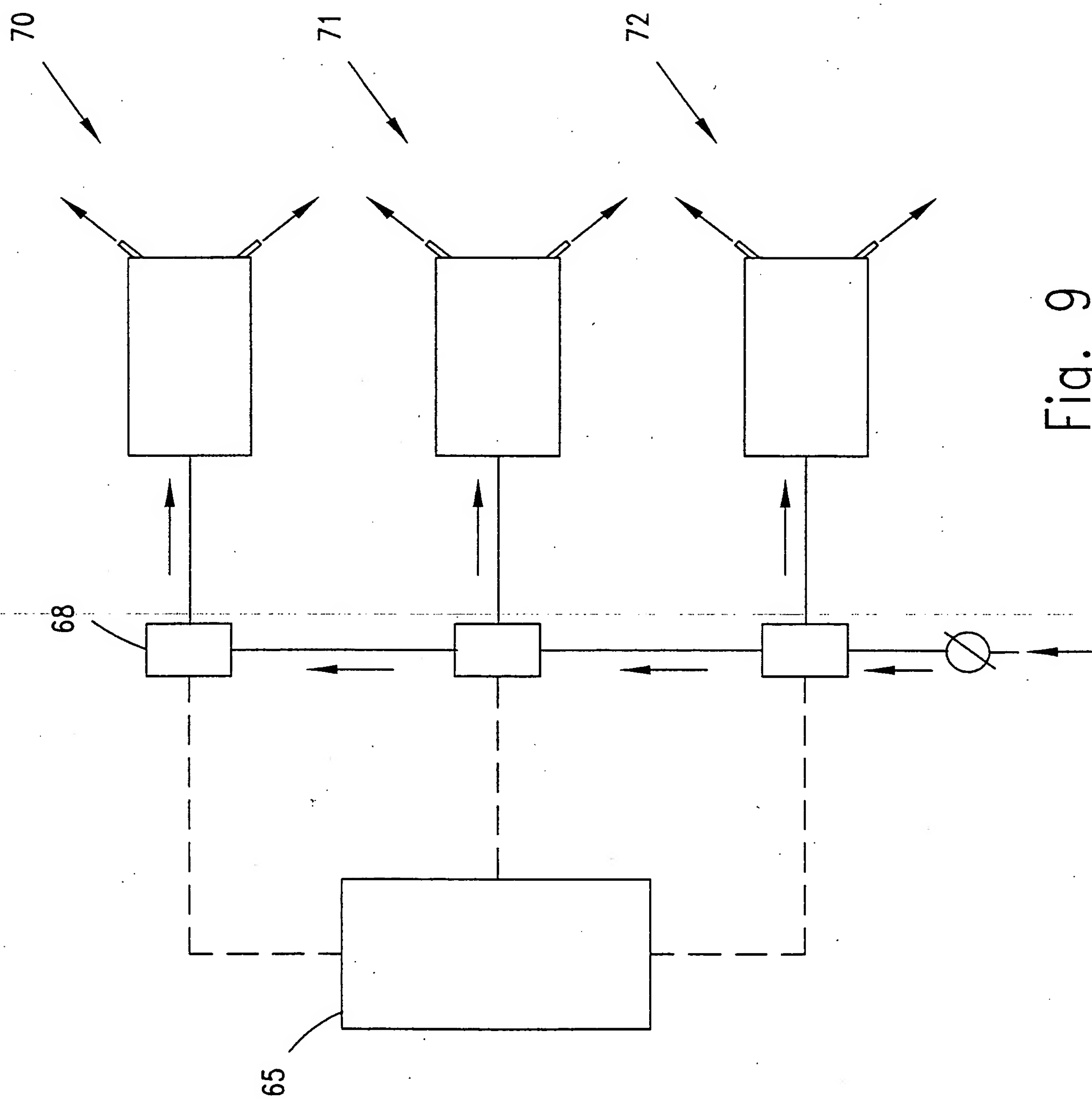

Fig. 9

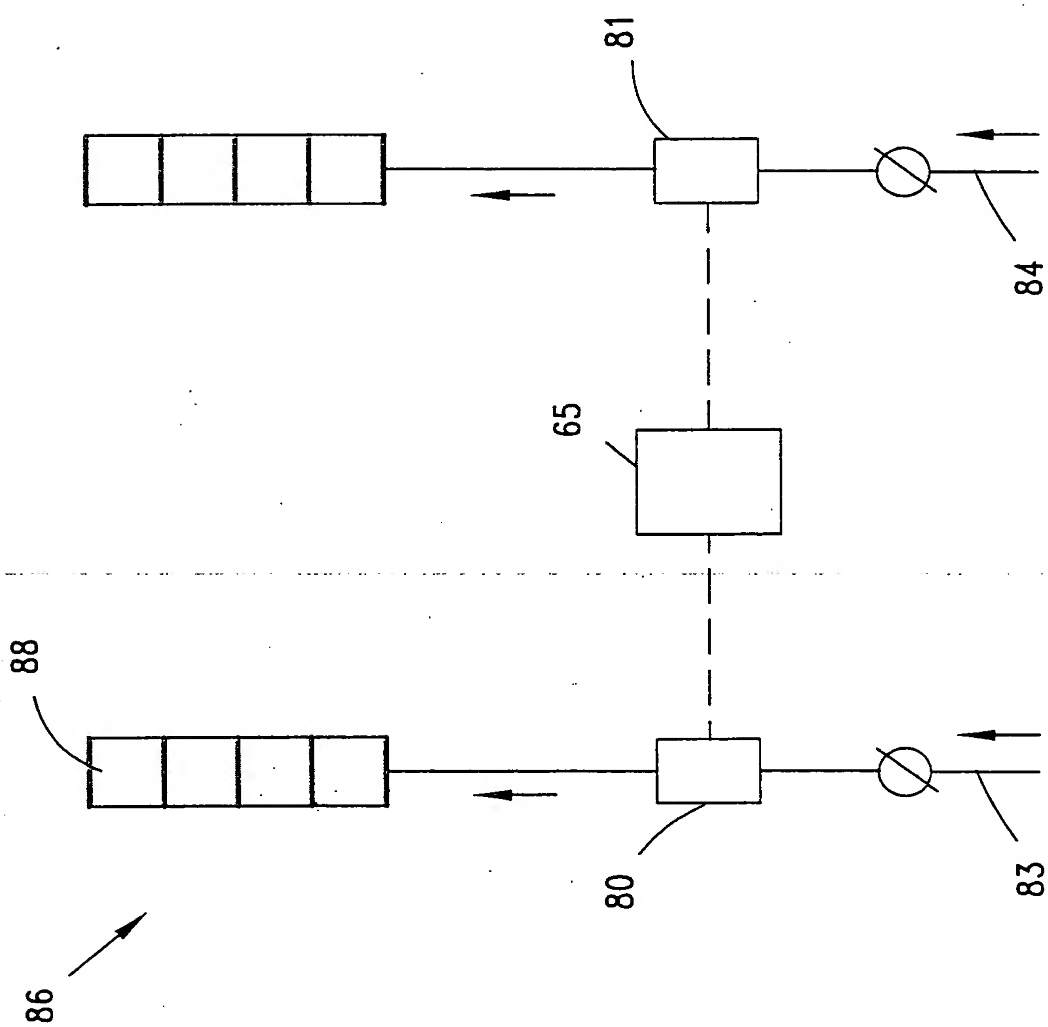

Fig. 10

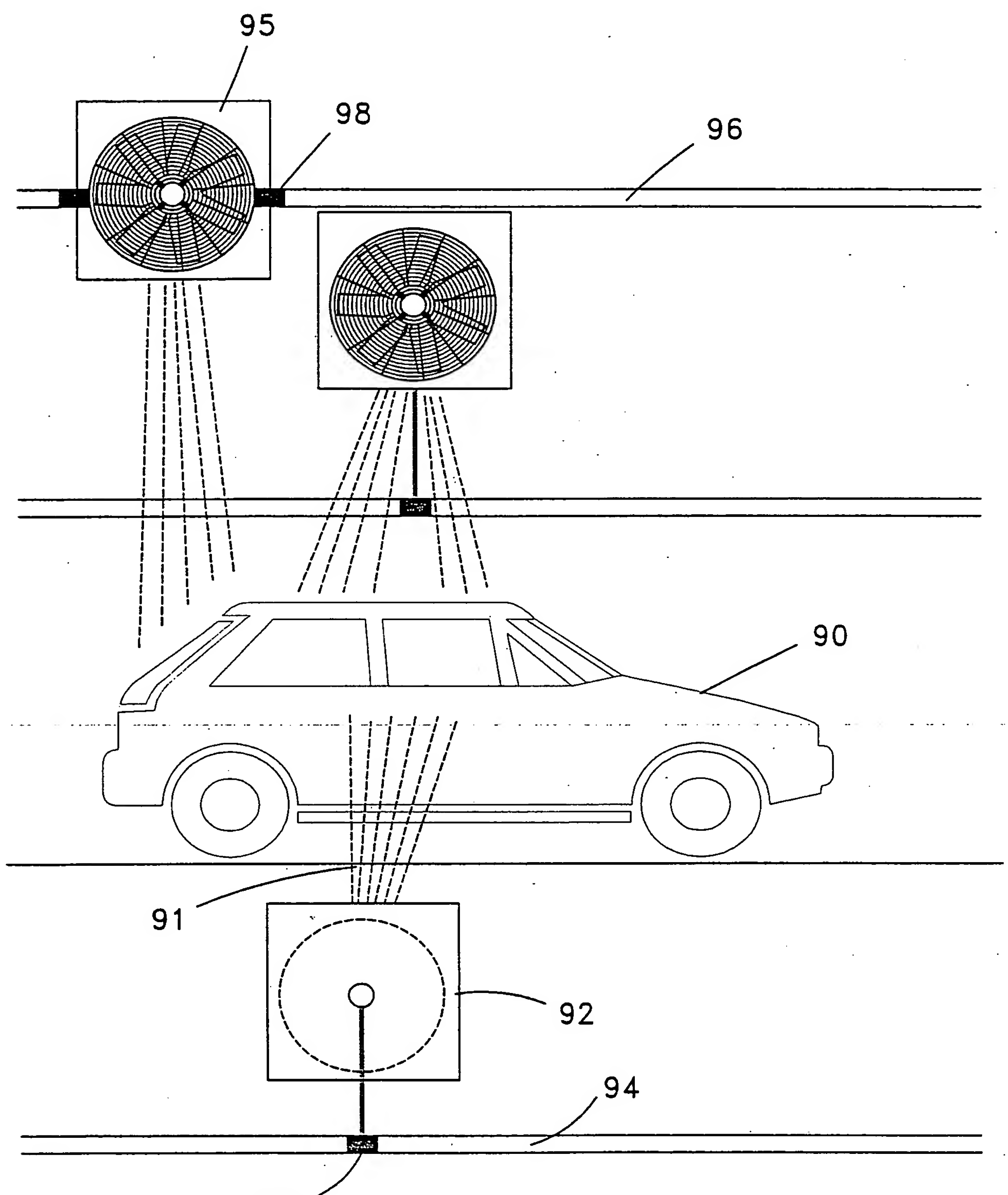

Fig. 11

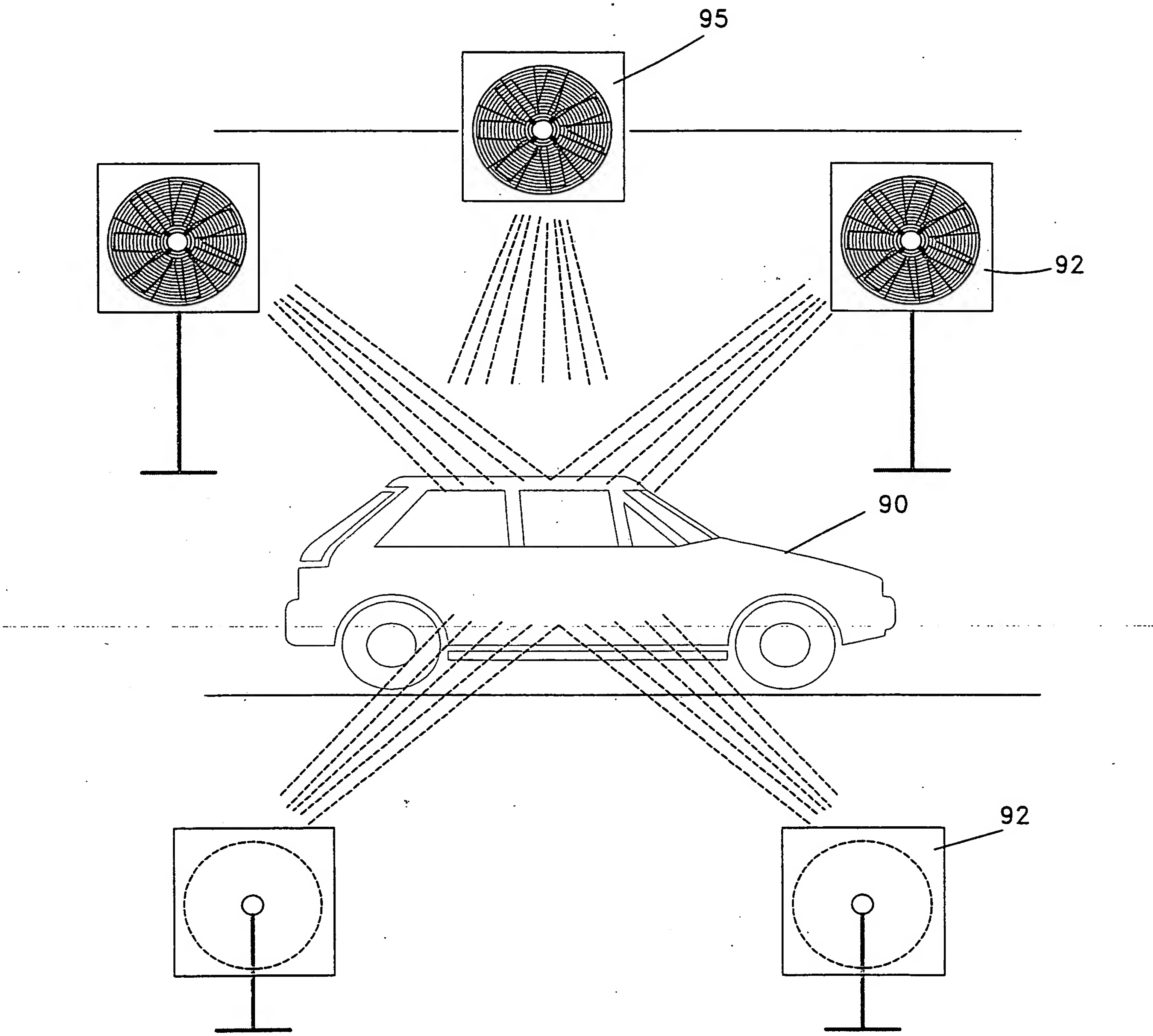

Fig. 12

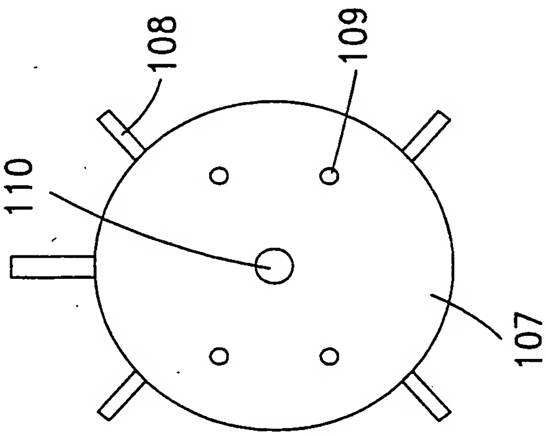

Fig. 13b

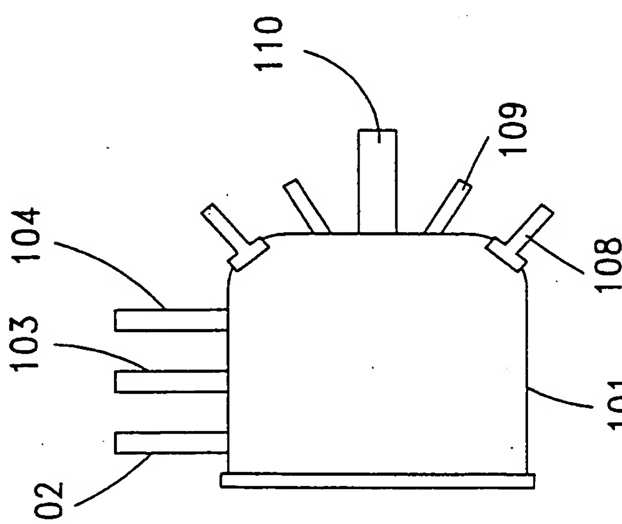

Fig. 13a